THE TELEGRAPHIC JOURNAL.
VOL. IV.—No. 87.

A PRESIDENTIAL ORATION.

THE great and increasing importance with which the public mind in this country invests the address delivered by the President of our great scientific gathering, is a fact familiar to all; and widely as the long series of these addresses has varied in substantial worth, this deep and general interest appears to be amply justified. From the recent proceedings of the French Association at Clermont, that institution, still in its youth, would seem to be destined to a career not unlike that of its elder sister. The eloquent address delivered by M. Dumas would doubtless command a large circle of readers, who could not fail to catch its enthusiasm, and admire the poetry and grace by which it is characterised. It might be instructive to compare this address with the one delivered a week ago by Professor Andrews, at the opening meeting of the British Association: both are of high value, though on different accounts; and they appear to us, in some degree, characteristic of the nationality of the speakers.

Such a comparison, however, is beside our present purpose; and we confine ourselves to the French address, which we would gladly reproduce in full, did occasion permit. The distinguished chemist commenced by tracing the history of the British Association; and showed what impulsion it had given to scientific researches, and how it had developed the intellectual life of the kingdom. He next delivered an able vindication of science, and spoke of the *rôle* which had been played by French *savans*, and especially members of the Academy, on the stage of history; then he noticed a regrettable tendency to leave to the State the responsibility of scientific progress, so that individual initiative was like to be effaced. This, he said, the Association set itself to remedy. The multiform ways in which science presented itself in daily life were eloquently descanted upon. We quote the following passages from the concluding portion of the address:—

"It is in vain, then, that you say, I will not occupy myself with Science; it will have a right to reply—'Even at the moment of your birth, I had woven the swaddling clothes that received you; throughout your life I have never been a single instant foreign to the acts of your existence; after your death, it is still in my name that men will direct the destruction or conservation of your mortal remains.' Science follows you everywhere; you breathe, it is chemistry; you walk, it is mechanics; every moment, without thinking of it, you have to do with her. Whether we wish it or not, we must accept Science as a companion, to possess her or to be possessed of her; if you are ignorant, you are her slave; if you are intelligent, she obeys you. * * *

"Excluding the soul, its origin and its destiny, which are in the domain of faith, the remainder of the universe belongs to science, which is in the domain of reason. With Pascal, it is true, man might say to the universe, as it fell to crush him, 'I am more noble than that which kills me; I know that it crushes me, and it does not know it.' But this passive universe is not merely a spectacle of sublime harmonies offered to the contemplation of our thought which rules it; it is also the source whence the body, which serves as a temporary retreat for the thought, derives its nourishment; the field in which man finds all that is necessary to his conservation, to his well-being, to the satisfaction of his ambition and the ardour of his curiosity. We leave the soul to God, morals to religion and philosophy, human passions to the poets, and march resolutely to the scientific conquest of the universe; the theatre is vast enough for our free discussions. We invite to our fellowship, on this pacific and neutral ground of natural philosophy, where all the victories are blessings, where the defeats cost neither blood nor tears, the hearts that are moved by patriotic desire; it is by science, and the high achievements of science, that our country will recover her prestige. * * *

"It has not been given to all men (said the orator, in conclusion, after referring to the joys imparted to the mind by the study of nature,) to embrace in one *coup d'œil* the course of wandering stars in infinite space, and the obscure agitations of the invisible particles of matter; but when Laplace cries, 'The curve described by a simple molecule of air or of vapour is regulated in a manner as certain as the planetary orbits; there are no differences between them except those attributed by our ignorance,' his ardent soul reveals to us that mathematicians have their poetry, and enables us to perceive what heights we must attain to, in order to enjoy to the full the spectacle reserved for genius in the splendours of creation."

THE AUTOKINETIC TELEGRAPH.

THE object of this invention, as stated by a prospectus, is "to enable each separate dwelling or place of business, in any particular town, at a trifling cost, to be placed in direct communication

with those public institutions established in the locality for the preservation and protection of life and property."

We must confess that from previous experience of inventions of this kind, we were at first inclined to class the one in question amongst those that are "very beautiful in theory, but in practice quite useless." Being, however, invited to inspect the apparatus at the office of the inventor, we came away, to say the least, quite convinced of the practicability of the invention.

The chief expense in connecting a private dwelling-house or warehouse with a fire-engine station is the cost of the connecting wires. In the ordinary system of telegraphy a separate wire would be required from each dwelling or warehouse, in order that undisturbed communication might be available at any moment. It is true that it is possible to have a number of instruments on one circuit, but then it is necessary that only one station shall signal at a time; no message can be sent by a second station until one which may have been transmitting a signal shall have completed its communication. Now, such a system would be quite inadmissible where "Fire" is the agent whose presence it is required to announce, for but few if any persons would be in a condition of mind, when such a calamity occurs, to go to an instrument, and if he finds the circuit on which it is placed already occupied, to wait calmly until he sees that the line is clear, and then to signal an alarm.

The inventor of the Autokinetic Telegraph has had the two difficulties of cost and certainty of communication in view, and has succeeded in overcoming them.

It will be clear, for the reason we have given, that a contrivance for announcing "Fire," or "Thieves," should do so by the simple movement of a handle, or the depression of a button; anything involving several operations would be quite inadmissible, but the simple movement of a handle could be accomplished by any person, no matter how nervous.

The problem, then, is to devise an apparatus which, by the simple movement of a handle, shall signal the nature of the help required, the locality of the place where assistance is required, and such that this shall be done as cheaply as possible.

In the Autokinetic Telegraph but two wires are employed for almost any number of houses, as by a most ingenious arrangement, if the handle or button at any house on the circuit is moved whilst a signal is being transmitted from any other house on the same circuit, the signal is not transmitted until the first signal is completed. The movement of the handle, in fact, sets the apparatus, which is let off, on, and by the cessation of the current sent by the first signal.

The way in which this is accomplished cannot be fully explained without the help of a large number of diagrams; but the following will explain the general principle of the arrangement.

The apparatus may be divided into three parts—"The Receiver," "The Transmitter," and "The Switch."

Each circuit (of two wires) has one receiver fixed at the terminal station to which the alarm is to be transmitted, and a transmitter and switch-handle at each house from which it is required that an alarm signal can be transmitted.

The transmitter is a clock-work apparatus, on the axle of one of the wheels of which are fixed discs with their circumferences notched. A small lever presses against the circumferences of each of these discs, and lifts or drops into the notches as the discs rotate, thereby making a series of contacts of long or short duration according as the notches are set close together or are far apart. By arranging these notches, it is evident that the rotation of the discs can be made to constantly transmit any required signals.

The clock-work which rotates these discs is set free by the action of an electro-magnet.

The switch-handle which is moved by the person sending an alarm signal is provided with one or more contact studs corresponding to the discs on the transmitter. When the switch-handle is moved to one of the contacts against which "Fire" is marked, for example, the disc corresponding to that contact on rotating transmits the signal · · — · or F, followed by the number of the house · · — — — or 2, for example, the notches in that disc being cut to transmit those signals.

The battery for sending the signals is placed at the receiving station, and when the switch at any station is moved, it is put in circuit to earth through the switch and one of the discs. In circuit with the battery is the receiving instrument, which is an ordinary Morse writer, the clock-work of which is set in motion by the action of the current.

In the case to which the switch-handle is fixed, there is an electro-magnet which holds the handle against the contact to which it is moved, so long as the signal from that house has not been transmitted or completely finished.

By means of the second wire, when the signal has been completed, the electro-magnet of the switch ceases to hold the handle of the latter, and it returns to its normal position, thereby indicating that the signal has been completed. This return movement of the handle also restores the whole transmitting arrangement to its normal condition, and sets off the transmitter of the next station which may have moved its switch-handle.

The apparatus may appear complicated from the description, but there is really but very little mechanism about it, and that of a very simple character.

Fig. 1 represents the Transmitter.

Fig. 2 the Receiver. The barrel, with three springs pressing against it, shown on the latter, is a commutator for first putting the current from the battery through an alarm-bell, and then through the Morse-magnet after the bell has rung a short time.

Fig. 3 shows a Switch-handle with two contacts.

The inventor of the Autokinetic Telegraph suggests that pillar-boxes containing switch-handles similar to Fig. 4, should be placed at different points in streets, so that a policeman can summon assistance, if required.

Several other suggestions and modifications of the apparatus are made by the inventor, which want of space prevents us from giving.

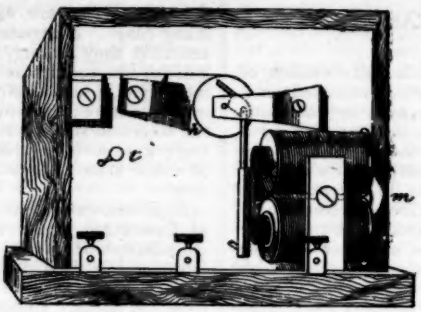

FIG. 1.

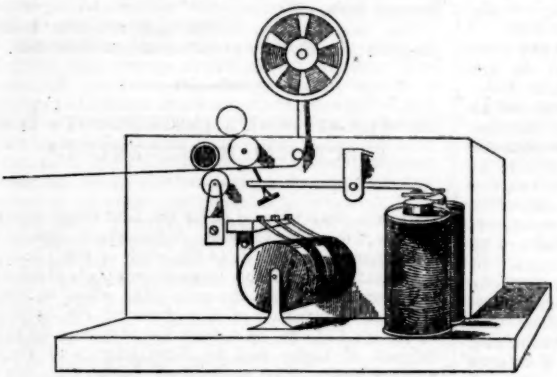

FIG. 2.

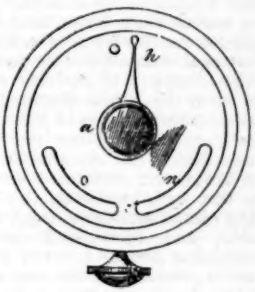

FIG. 3.

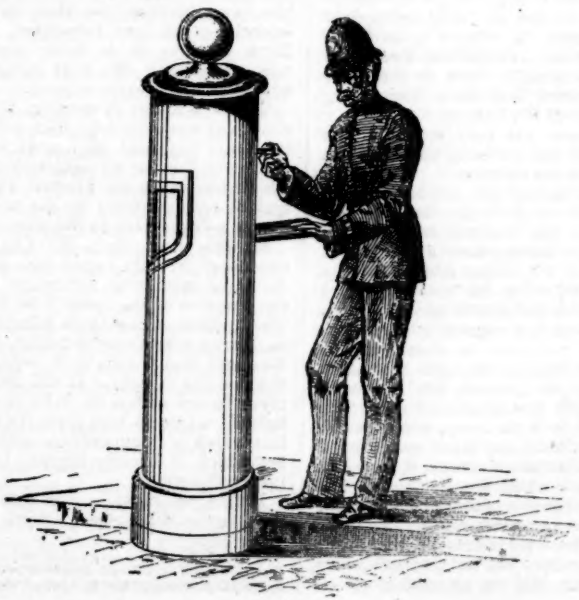

FIG. 4.

A NEW FORM OF GALVANIC BATTERY.

THE positive electrode of this cell consists of a hollow split cylinder of zinc, enclosed in a vitreous clay chamber, perforated by numerous small holes. The zinc plate is supported by a cork cap which fits into the mouth of the chamber, and prevents evaporation of the exciting solution. A narrow pipe acts as a vent for the escape of gas. The negative electrode consists of a carbon plate platinised; and the whole space between the perforated chamber and the outer walls of the cell is closely packed with mixed lumps of platinised carbon and manganese dioxide. The exciting liquid is a saturated solution of the crystallised form of ammonium chloride. The poles of the cell are, of course, fitted with suitable terminals. A coating of wax-cement is run in to seal the mouth of the cell.

This cell is advantageous in several ways over the older forms of manganese batteries. In the latter a porous clay chamber (as in Leclanché's) or a canvas cloth (as in Grenet's) is employed to separate the two electrodes, and a great increase of internal resistance is the result, in consequence of the formation of insoluble oxy-salts of zinc in and upon the porous diaphragm. Moreover, the gradual accumulation of these salts of zinc often bursts or disintegrates the porous separator. These defects are obviated in the new battery by the use of the perforated vitreous cylinder. In the new cell, moreover, the negative electrode being placed *outside* the inner chamber instead of inside, and surrounded by the carbon and manganese lumps, a much greater depolarising mass is presented to the zinc, while the resistance of the negative electrode is diminished. The zinc being cast hollow, offers a much larger surface to the exciting liquid than the old solid cylindrical form, and consequently a larger *quantity* of electricity is generated. Its hollow form also permits of its being brought close to the inner surface of the perforated cell, thus diminishing the internal resistance of the battery.

Further, the platinum not only increases the depolarising effect of the carbon, but also the electro-motive force of the element.

The electro-motive force of this cell is about 1·6 volts as compared with a Clark's standard element, which is 1·457 volts. Its internal resistance is about 0·5 ohms. The electro-motive force of a Daniell cell is about 1·1 volts; and that of a Leclanché is about 1·5 volts; but owing perhaps to its polarising nature the results given for this cell vary considerably. As regards polarisation the new cell falls 1 per cent in electro-motive force after being connected through 100 ohms resistance for one minute, whereas the Leclanché falls 2½ per cent. After five minutes through 100 ohms, the new cell falls 2 per cent., whereas the Leclanché falls 5 per cent.; and after ten minutes' working through the same resistance, it has still fallen only 2 per cent., while the Leclanché has fallen 10 per cent., and goes on falling beyond that time, whereas the new battery remains constant.

The Daniell is acknowledged to be the most constant working battery; but its comparatively low electro-motive force and the amount of attention it requires are against its employment in many cases. Manganese batteries, from the little attention they require, are much to be preferred. They are especially useful in working bells or local telegraphs, where their operation is of an intermittent nature; but when kept constantly at work, the objection to them is that they lose power, from their excessive polarisation. This polarisation, as above stated, is much reduced in the new battery.

Experiments made in the Cavendish Laboratory at Cambridge, under Professor Clerk Maxwell's superintendence, show that the electro-motive force of this new cell continues constant when worked through some resistance little different from 100 ohms. Under that there is a slight percentage of fall, and over that there is a slighter percentage of rise in its value. (See *Nature* for October 28th, 1875.)

The new battery, which has recently been patented, has already found considerable favour.

ON WHEATSTONE'S INSTRUMENTS FOR ELECTRICAL MEASUREMENT.*

UP to the year 1833—*i.e.*, for the first thirty years of his life, Sir Charles Wheatstone devoted himself more especially to the study of the Theory of Sound, and to the improvement of Musical Instruments. From the year 1834, when he was appointed Professor of Experimental Philosophy at King's College, he turned his attention to the subject of Light and to Electricity, and their applications. The subject of Light has been omitted from this course of lectures, not because his investigations in that subject were less interesting or less important, but because in three lectures it is quite impossible to deal adequately with the wide range of subjects in which he has greatly extended our knowledge.

We have to-day to consider the very important electrical work done by him, principally between the years 1833 and 1843, work which has formed the foundation for all electrical measurement, and which has made the Electric Telegraph possible, and so supplied what we are now accustomed to regard as necessary to the progress of civilisation.

In the year 1834, Sir Charles Wheatstone conceived the very happy idea of making use of a revolving mirror to determine the velocity and the duration of the spark from a Leyden battery. The method of causing a mirror to rotate rapidly has borne very important fruit, for by means of it Foucault and Cornu have separately determined the velocity of light. It has also been applied by them to determine the fact that the velocity of light in water is less than its velocity in air—a fact which is in accordance with the wave-theory but which is directly opposed to the corpuscular theory of light.

Hence, we must reckon among the results of Sir Charles Wheatstone's work the distinct proof

*Abstract of one of a series of three Lectures on Wheatstone's discoveries and inventions, delivered by Prof. W. G. Adams, at the Royal Institution (May 23—June 6, 1876).

that light does not consist of solid particles shot out from a white hot body.

In attempting to give you an idea of some of the most important of Sir Charles Wheatstone's work—his methods of electrical measurement—I have set to myself a difficult task; and, first of all, as we were very well told by the able lecturer on Friday evening, in dealing with measurements, we have entirely to get rid of that disturbing element "Wonder"; so that we can no longer appeal to that to help us in rivetting the attention, unless indeed (knowing how liable he is to fail) we "wonder" at the accuracy to which man can attain, and are struck with the agreement between the laws of Nature and the results of man's investigation of them.

We are to-day concerned with that broad, general principle, so ably explained by the lecturer on Friday evening—the principle of "Conservation of Energy."

We have to deal with energy in the form of Capital—*i.e.*, energy stored up for use when it is required, such as the energy stored up in a charged electrical machine, or the energy stored up in a galvanic battery. We have also to deal with energy in the form of Labour—*i.e.*, work or heat, as in the electric spark, or in the resistance overcome by an electric current flowing from the reservoir or source of electricity, in which it is stored up. Energy in the form of capital is sometimes termed potential energy, and is estimated by the work which it is capable of doing; thus, a galvanic battery has potential energy, and a reservoir of water has potential energy, which is changed into work done by the current of electricity or of water as soon as a way is opened for the current.

If, for instance, we place a syphon in our reservoir, and fill the syphon, we open a path for the water to flow to a lower level, and the water flows down. The difference between the potential energy which it had at the higher level and at the lower is converted into work, which may be shown by causing it to turn a water-wheel, which will give us some measure of the current. When at the lower level, it is not capable of doing so much work as it was capable of doing before it fell, and the amount of work which it can do will depend on the height of the reservoir above the lower level. In this case, we see that difference of potential energy means difference of level, and we can only get a flow of water from a higher to a lower level. We see that the flow of water from one point to another depends upon the difference of of potential between the two points. The total amount of work which any body of water is capable of doing depends upon its height above the level of the sea, and it does that amount of work in flowing down, either in overcoming resistance or in producing motion in itself or in other bodies. When it reaches the dead level of the ocean, its power of doing work is gone.

Now, we shall see that there is a very exact analogy between currents of water flowing from a higher to a lower level, under the action of the attraction of the earth (the force of gravity), and currents of electricity flowing from a higher to a lower potential; the analogy is so close, that we may use the word "level" figuratively in place of electric potential. It is by means of this analogy that I hope to make clear to you one of the most important parts of Sir Charles Wheatstone's work.

When water flows in a straight channel from one level to another, the resistance it encounters will depend on the horizontal distance between the two ends of the channel. When it falls vertically, the bed of the channel offers no resistance, for the water falls freely; but when the channel is on an incline, the resistance increases as the bottom gets farther and farther away from the vertical line through the upper end. And as this resistance increases, the current diminishes, for the strength of current will depend upon the slope. Now, according to Ohm's law for electric currents, the same relation holds true. For a given electro-motive force—*i.e.*, a given difference of level—if we represent the resistance by the length of a horizontal line, the strength of current will be represented by the slope of the incline.

Let us examine a little further the meaning of difference of level with regard to electricity.

According to the contact theory of electricity, different substances are at different levels with regard to electricity, and this difference is shown by a current from one to the other when they are connected by a suitable channel. Again, when two metals are soldered together at one end, and their other ends are joined by a wire, the application of heat to the soldered junction causes a difference of potential, and there is a current which circulates through the wire from one metal to the other. Again, the two metals at the two ends of any electric battery are at a different level, so that the electro-motive force of a battery will be different according as we use different metals; thus, with zinc and copper, we get one value, while with zinc and platinum we get a much higher value. We may say that the level of copper lies between the levels of platinum and of zinc, and may arrange the metals at their proper relative levels by the currents which can be produced in a wire of the same constant resistance.

In the flowing down of an electric current from a higher to a lower level, work is done; and, as in the water-wheel, the deflection of the magnetic needle round which a current passes may be regarded as the index of the strength of current.

In the case of the galvanic battery, if we open a path for the electricity by joining the two ends of the battery by a conductor, we have a difference of level with regard to electricity at the two ends, and a current flows from the higher to the lower level.

As in the case of water, the velocity or strength of current will depend on the resistance in its path, and, like a narrow channel, a thin wire offers greater resistance than a thick one. Ohm has given us the law, and Wheatstone has given us the instruments with which to measure the differences of potential or the electro-motive force of a battery, and the resistance of any conductor and the relation of these quantities to the current.

We can conveniently represent Ohm's law geometrically, and this method of representation will enable me to explain one of Wheatstone's

methods of comparing electro-motive forces of batteries by means of the rheostat.

In most of his researches Sir Charles Wheatstone employed a modified form of Daniell's battery, using a liquid zinc amalgam in place of zinc in sulphuric acid for the negative pole.

Not only does the rheostat afford a means of determining the electro-motive force of a battery, but also of determining the resistance of a conducting wire.

This is done by first placing the wire to be measured in the circuit with a battery and galvanometer, and noting the deflection of the needle of the galvanometer; then, removing the wire, an additional equal resistance is added by increasing the length of rheostat wire in the circuit, until the deflection is the same as at first. The added resistance is then equal to the resistance of the wire to be measured.

In comparing currents of different strengths by means of the deflections of a galvanometer-needle, it becomes necessary to know the relation between the current and the deflection which it produces. If a current of given strength produce a given deflection, it is necessary to find what deflection corresponds to a current of half the strength.

Sir Charles Wheatstone proposed a simple method of determining the value of the deflections of the needle of a galvanometer.

According to the theory of Ohm, when a current of electricity is divided so as to pass through two channels, the strength of current flowing in each channel will be inversely as the resistance of the channel.

We may illustrate it by the flow of water from one level to another by two separate channels; the rate of the current will be greatest along the shortest path—*i.e.*, where the degree of slope is greatest. Thus, in a desk the slope down the edge is greater than in a diagonal direction on the sloping surface, and the greatest current would flow in the former direction.

The plan adopted by Sir Charles Wheatstone was this:—He first passed a current through a galvanometer, and, according to Ohm's law, the strength of current $= \frac{E}{R + r}$ (r being the resistance of the galvanometer, and R all the other resistances). Now, divert part of the current from the galvanometer, by connecting the galvanometer-poles by a wire whose resistance r is equal to that of the galvanometer, the strength of the principal current will now be $\frac{E}{R + \frac{1}{2}r}$ If now an additional resistance equal to $\frac{1}{2}r$ be added to the circuit, the current will be $\frac{E}{R + \frac{1}{2}r + \frac{1}{2}r}$ or $\frac{E}{R + r}$ the same as at first. Now, only half of this current flows through the galvanometer, so that the deflection of the galvanometer in the second case will indicate a current of half the strength of the first current.

The most important of the electrical instruments with which Sir Charles Wheatstone has supplied us is the Wheatstone Bridge or Wheatstone Balance, for comparing directly the electrical resistance of two conductors of electricity. Its principle may be illustrated experimentally by means of the flow of water from a higher to a lower level.

Thus, let us take two equal glass tubes A, C, diverging downwards from a reservoir of water, and terminating in bulbs, E, F, from the upper part of which, again, there descend, convergently, two similar and equal tubes B, D, to another vessel. A straight tube also connects the bulbs E and F. When water is admitted at the top, it flows through the tubes A and C, and fills the bulbs E and F; then it flows by the tubes B and D to the lower vessel. When the bulbs E and F are on different levels, a portion of the water will flow from the higher to the lower of these bulbs, through the tube E F, joining them. If E be higher than F, then water will flow from E to F, *i.e.*, from the higher to the lower level; but when E and F are on the same level, then the currents will continue to flow along A, B, C, and D, but no current will flow from E to F, or the reverse.

Now, if we regard the flow of electricity instead of water, we have four resistances in place of the four tubes A, B, C, and D, and at the points E and F the galvanometer-poles are attached, and the battery-poles are attached at the points where the wires diverge and meet again.

When the resistances of A, B, C, and D are so related that the ratio of A to B is equal to the ratio of C to D, then the points E and F are at the same *level* or the same potential with regard to electricity, and no current flows through the galvanometer from E to F.

Now, the object in this case is attained when no current flows through the galvanometer, and this may be attained by altering one or more of the resistances. If three of the resistances are known, then the fourth resistance will be determined; or if two of the resistances are known, the ratio of the other two resistances is determined.

[The lecturer further explained the Wheatstone's Bridge of the ordinary form for small resistances, and compared the resistances of two wires by means of it. He also shewed how to measure high resistances by measuring the resistance of *selenium* by means of a set of resistance coils, and concluded by shewing the diminution produced in the electrical resistance of selenium by exposure to light, and the use which may be made of this remarkable property for comparing or measuring the intensity of light from various sources.]

THE PNEUMATIC SYSTEM IN BERLIN.

THE system in course of organisation in Berlin for pneumatic transmission of letters or telegrams is (according to *Hamburger Nachrichten*) rapidly progressing, and is expected to be ready for use in October. The technical arrangements have been under charge of M. v. Felbinger, who directed similar work in Vienna. The pipe-laying through the streets, which is in the form of two large rings and various branches, is now completed; and the setting up of air-reservoirs, and steam-engines to work the air-pumps, is nearly so. The two rings,

on this and the other side of the Spree, into which Berlin is divided for the pneumatic system, are connected by a double line (of pipe) between the Central Telegraph Office (on this side of the Spree) and the Exchange (on the other side). The letters or telegrams can be driven through both rings partly by air-pressure, partly by rarefaction, in half an hour (inclusive of the operations in transmission). As, in most cases, the dispatches have to traverse only one ring, or less, the pneumatic sending of a message requires, as a rule, hardly a quarter of an hour. Each of the two rings has two engine-houses at suitable distances apart. By steam-power the reservoirs there and at neighbouring stations are filled with either compressed or rarefied air, according to the mode of transmission. The arrangement is such that in any portion of tube the cases may be sent in one direction or the other (by compression or rarefaction). At first, however, this to and fro transmission will not occur in the peripheries of the system; but the dispatches will be all in one direction—the right; so that a letter which has to go to a neighbouring station on the left, will have to traverse nearly the whole ring, whereas a letter which has to go to the opposite and most distant part of the ring is sent through only half of the ring. Only in the branch-tubes, which extend from the periphery of the ring to the most distant parts of the city, and also in the tubes connecting the two rings, is the mode of dispatch in either direction (by compression or rarefaction). Along with the subterranean tubes run telegraph wires, by which each station can announce to the others the departure or arrival of messages. There are altogether fifteen stations, twelve of which are within the two rings, and three beyond.

Notes.

FROM the twenty-second Report of the Postmaster-General, just published, it appears that the actual net earnings of the telegraph service for 1875 amounted to £153,600. The total revenue in the year ending 31st March was £1,623,838, as against £971,217 in 1871. Nearly 1,650,000 more messages were dealt with in 1875 than in 1874. The number of post-offices open for the transaction of telegraph business at the end of the year (1875) was 3,730, or 31 more than the number open at the end of 1874. This is a small increase compared with some former years, but the system had already been extended to nearly every place where the revenue could be expected to meet the expense involved. Of the 31 new offices, most were opened at the request of the inhabitants of the district, who guaranteed the Department against actual loss. In addition to the 3,730 post-offices, 1,872 railway stations were opened for the transaction of public telegraph business. Though the additional mileage of wire was small, yet improved apparatus and methods of working effected greater expedition with the increased number of messages than in previous years. The revenue from rentals of private wires, though showing a less increase than in former years, was at the rate of upwards of £56,000 a-year.

The Council of the Institution of Civil Engineers has just published a list of forty-seven subjects, on which communications are invited, certain premia being also offered. We note that one of the subjects is—"On Recent Progress in Telegraphy, including a Notice of the Theoretical and Practical Order on which that Progress has been based; with some account of the improvements in the construction of land and sea lines, and in the working instruments."

An excellent portrait of Sir William Thomson, with a sketch of the life of that eminent physicist, appears in our contemporary, *Nature*, for September 7.

In a laboratory for the study of plant physiology at Vienna, M. Velten has recently made experiments "on the action of current electricity on the motion of protoplasm, on living and dead cell-contents, and on material particles generally." He has observed that strong induction-currents sent through an aggregate of cells, or a single cell, set the contents in rotation, which closely resembles the vital motion of circulation, gliding &c.; both following the same laws. Induction and constant currents produce, in the starch-granules and other particles enclosed in cells, rotations about their own axes, which are quite similar to those observed in chlorophyll granules in living cells of chara. In both cases the granules can be also made to perform the greater rotation. The hypothesis deduced from from these experiments is, that the cause of protoplasmic motions is to be sought in electric currents produced by the living cell-contents themselves.

A new railroad signal has been in use on the Boston, Lowell, and Nashua Railroad, for a short time past, which appears to solve the problem of making the rails serve as conducting wires in an electrical circuit governing the signal mechanism. It is described and figured in the *Scientific American* (29th July); is simple, and said to be very effective. A single cell Callaud battery is connected to the two rails at one end of a given section of the line, say two miles in length (each section being insulated from adjoining sections). At the other end the signal has an electro-magnet similarly connected to the two rails. When the circuit is

closed, as is normally the case, the magnet is excited and the signal controlled thereby so as to show "line clear." When, however, a train runs on the section, the circuit is completed by the wheels and axles, and the current returns to the battery by the shorter course opened to it, instead of passing through the signals. The magnet ceases to attract, and the signal by mechanical means is at once turned to "danger." The device may be applied over an entire line, and will indicate the condition of every section thereof to the train about entering the same. It is found to be operative in all weathers, and there is no drawing off of the current of the earth under the rails. The single Callaud cell will last for 158 days.

Dr. Robert Newman, of New York, lately introduced to the State Medical Society a new element, consisting of zinc and gold upon lead. It was maintained that batteries containing elements made in that manner possessed 25 per cent. more force than either the Dawson, the Byrne, or the Bunsen battery. The doctor did not exhibit a battery, but presented four pairs of elements, simply for the purpose of showing the initial force of each. A battery constructed upon this plan would cost thirty-five dollars.

A very rare kind of lightning flash was lately seen at Paris. It is designated by M. Planté the *éclair en chapelet*, or "chaplet flash," being like a string of brilliant beads arranged along a luminous thread. The phenomenon is a consequence of the flow of the electric fluid through a ponderable medium, and is quite analogous to the row of incandescent globules presented by a wire that is being fused by a voltaic current, and to the swellings and nodes of a flowing liquid vein. It is a transition form of lightning between the straight or curved-line flashes and the globular form.

A curious electrical effect was observed by M. Trécul during a thunderstorm on the 18th ult. He was writing at his open window at the time. When the thunder seemed nearest, some small luminous columns descended on the paper; one was about 2 metres long, and 0·15 metres wide at the widest part. Obtuse at the further end, they gradually thinned to 3 or 4 centimetres at the surface of the table. Their appearance was that of inflamed gas with ill-defined contour; their general colour, not intense, was yellow, slightly reddish, but at the paper surface the tints were more lively. In being extinguished, they left the paper with a slight noise (or *bruissement*, the first syllables of which word, M. Trécul says, somewhat imitate the sound).

In a new contrivance by M. Bourbouze, the movement of a pendulum is maintained by means of a magnet fixed to the upper part and moving in a rectangular bobbin with two wires (like that of a galvanometer); currents being sent alternately in opposite directions through the wires. A figure of the apparatus will be found in *Comptes Rendus* of 21st August.

According to the official Report for 1875 (recently published), of the German Post and Telegraph system, the entire length of telegraph lines in the 'Reich' (excluding Bavaria and Wurtemberg) was 132,000 kilometres. (The extent of country is estimated at 445,261·47 square kilometres; and the population 35,851,474.) The number of telegraph offices, including railway telegraph stations, 4,338; apparatus, 4,477; *personnel*, 4,610. The entire number of telegrams handed in was 9,003,379, of which 1,169,652 were for foreign parts. The entire income was 10,258,529 marks; the expenditure, 15,958,543 marks. July was the month in which most telegrams were sent (869,085); February, the fewest (581,799). Comparing with the previous year, it is found that the telegraph net-work has been increased by 11,230 kilometres; the offices, 422; apparatus, 571; *personnel*, 44. The number of inland telegrams increased by 172,115; foreign, 21,972. The receipts were increased by 561,002 marks; the expenditure by 333,670 marks.

In New York, one day recently, a rotten telegraph-pole at a street-corner fell, and killed Mrs. Ann Maguire, who was passing at the moment. At the inquest, the responsibility for the accident seems to have been placed on the city, while the pole was said to have belonged to the Manhattan Telegraph Company. Several other dangerous poles have since been removed; and the Board of Aldermen now require the ownership of every telegraph-pole in the city to be distinctly painted thereon.

The Bahia Rio de Janeiro section of the Western and Brazilian Telegraph Company's cable was interrupted to the 29th ult., and intimation has been received of an interruption on the Rio Grande do Sub-Monte Video section.

The American District Telegraph system appears to have become highly popular in San Francisco. By turning a small crank on a box fixed to the wall of your room or office, you summon promptly to your aid a well-trained telegraph-boy, who will do service as required,

Turning the crank to "Fire," you cause the number of the house to be at once telegraphed to the fire-patrol. Similarly, a policeman may be called. There are now 500 of these automatic boxes in San Francisco, and arrangements are being made for establishing the system in several other large towns in the Western States.

A telegram may now be sent from Balta Sound, the extreme point in Shetland, to Jersey, for one shilling.

The "Papyrograph" of M. Zuccato offers considerable facilities in the printing of drawings or manuscripts, which is done by means of an ordinary office copying-press. As many as 500 copies, it is stated, can be produced from a single sheet of Papyrographic paper with one inking, at a cost of 2d. or 3d.

The following are notes of traffic receipts:—

At a meeting of the Great Northern Telegraph Company in Copenhagen, on 26th August, the increase of half a million francs in the receipts since January, as compared with the corresponding part of last year, was stated to be due to the increased traffic between Europe and Japan and China, by way of the Company's route *viâ* Wludiwostock. A convention with Russia was sanctioned, furnishing the Company on easy terms with £500,000, to duplicate the lines on that route.

Western and Brazilian Telegraph Company, for August, £7,469, against £9,294 in the corresponding month of last year.

Direct United States Cable Company, at 3s. per word, for week ending 2nd September, £3,300; 9th September, £3,700.

West Coast of America Telegraph Company, for four weeks ending 3rd June, 1876 (at 4od. per dollar), £2,791.

Cuba Submarine Telegraph Company, for August, 2,547 messages, estimated to produce £2,300, against 2,279 messages, producing £2,185, in corresponding month of last year. The traffic receipts for June, estimated at £2,600, realised £2,511.

Great Northern Telegraph Company, for August, 503,778 francs (against 386,681 francs last year). Total, 1st January to 31st August, this year, 3,213,673 francs (against 2,732,771 francs last year).

The average time in transit between London and India of all outward messages of the Indo-European Telegraph Company, *viâ* Teheran, was, for the weeks ending August 4th, 11th, 18th, and 25th, 68, 42, 39, and 41 minutes severally.

Electrical Science in Foreign Journals.

POGGENDORFF'S ANNALEN DER PHYSIK UND CHEMIE. No. 6: 1876 (25TH JUNE).

On the Laws of Passage of Electricity through Gases (concluded). By M. WIEDEMANN.

This important paper (in Nos. 5 and 6) describes continued researches. We give briefly some of the results. Connecting one of the electrodes of the discharge apparatus to the positive electrode of the machine, and the other to earth, M. Wiedemann got fewer discharges than in the converse case; and this occurs when, in the two cases, exactly equal quantities of electricity, in equal times, are transferred between the electrodes. Where the discharge is enclosed, the quantity of electricity required for it is, within certain limits (where the reciprocal action of electricities on the electrodes may be neglected), independent of the length of the tube between the electrodes; it also varies very little, within certain limits (where the reaction of electricity accumulated on the inner surface of the tube may be neglected), with increase of section of the tube; in spherical enclosures, it depends but little, within limits, on the radius of the sphere. With equal pressure and intensity of current, the discharge intervals are greater in air than in hydrogen. Again, with capillary tubes, and increasing pressure, the elevation of temperature in the tubes through each individual discharge increases at first in less ratio than the increase of the pressure, up to the pressure at which the relative maximum of the discharge interval occurs; with higher pressure, it increases much more quickly than before, but nearly proportionally to the increase of pressure. Other conditions equal, the heating of each section of a shorter or longer capillary tube is nearly the same. Tubes of different inner, but the same outer, diameter, receive in equal times, through the discharge, nearly equal quantities of heat. When the capillary tube or glass sheaths of the electrodes were heated slightly, the number of discharges was little affected; but with strong heating it increased considerably. M. Wiedemann also describes observations on the electroscopic charge of the capillary tube, and the effect of interrupting the circuit by a small interval of air. He then discusses the nature of the passage of electricity through gases. The original impulse is from the electrode, and the electrified quantity of gas next it moves in the direction of the quickest decrease of tension with a velocity proportional to the force previously pressing the gas on the electrode. In pure gas-discharge, the gas molecules do not fly from one electrode to the other. The case is similar to that of a row of suspended elastic balls; of which an end one is driven against its neighbour. The author next takes up certain points connected with the discharge —viz., the unequal expansion of the positive and the negative discharge, the place at which the *vis viva* in the moved masses ultimately appears as heat, the dark space at the negative electrode, and the stratification of the light. He then considers the principal of Hittorf's observations, with

an inductorium used instead of the electric machine.

On the Constants of Dielectricity of Liquids (second paper). By M. SILOW.

HE formerly gave the results obtained with the electrometer method; he here gives those obtained with the condenser method. In the following table the square roots of the constants by the two methods are shown, and the third column gives the refractive indices for infinite wavelengths:—

	$\sqrt{D}$ 1st Meth.	$\sqrt{D}$ 2nd Meth.	Refr. Ind. for $\lambda = \infty$
Oil of Turpentine.....	1·473	1·468	1·461
Benzol		1·483	1·482
Petroleum I.		1·439	1·422
Petroleum II.....	1·428		1·431

On Anomalous Data of the Gold Leaf Electroscope. By M. BEETZ.

THE cases considered are these:—1. A shellac rod, rubbed with catskin, is brought near the electroscope; the leaves diverge, and continue to do so after removal of the rod (if it have been held near for a few seconds), with positive electricity. The leaves now fall slowly together. If, while the divergence continues, the knob be touched a moment with a conductor, the leaves fall suddenly together, but they gradually open out again, and with negative electricity. This is explained by the — E of the leaves having, on approach of the negative rod, streamed out on the inner glass surface. 2. Touch the knob with the rod, then remove; the leaves diverge with positive electricity. The divergence remains after touching the knob with the hand. It decreases very slowly, and on touching again with the hand, is renewed, so that the electroscope recovers but difficultly its wholly unelectric condition. This, too, is due to a flow of — E out over the glass. These phenomena show the unsuitability of glass for electroscopes. Where it is used, there should be a tinfoil coat on the outer side of the vessel connecting the brass neck with the stand. M. Beetz makes an electroscope, in which the case is a horizontal brass tube (12 centimetres diameter and 8 centimetres long) supported on metallic feet. It is closed by vertical glass plates parallel to the plane in which the aluminium leaves diverge. It is very reliable.

CARL'S REPERTORIUM FÜR EXPERIMENTAL PHYSIK. XII. BAND. 4 HEFT.

Electrical Dust Figures in Space. By M. LOMMEL.

A BRASS rod pointed at one end, and with a ball at the other, is laid horizontally on an ebonite plate supported on wood; receives sparks from an electric machine; is discharged by touching and removed; and the plate is then sprinkled with a fine powder. The author gives drawings of the negative and positive figures obtained. Conceive these turned about their axes, and we have the electrical dust figures in space, of which the ordinary Lichtenberg figures are merely sections. M. Lommel fixed the brass rod in a certain position, and moved the ebonite plate up and down under it, taking figures in each position. He also used an ebonite plate with an aperture, allowing the brass-rod to pass through it. He shows how the various figures are related to the original two. The cause of the Lichtenberg figures is to be sought (he thinks) in a peculiar state of motion of the air about the conducting body, and this is simply imaged on the ebonite plate.

Physical Investigation of the Gramme Dynamo-Electrical Machine. By M. HAGENBACH, of Basel.

THE experiments show that the strength of current increases nearly proportionally to the velocity of rotation. With small strength of current, the electro-motive force increases with the increase of the strength. When, however, the current reached such strength as to develop 80 cub. cm. of oxy-hydrogen gas in a minute (at 0° and 760 mm.), the electro-motive force did not sensibly increase with increased strength of current, evidently because the weak current already sufficed to produce complete magnetisation. Further, with equal strengths of current, the electro-motive force increases nearly proportionally to to the number of rotations. M. Hagenbach's experiments on light production confirm Tresca's result, that the light can be had more cheaply from the large machines. The work done in production of the light of one Carcel lamp was 1·1 kilogrammetre. The machine was driven by a Schmidt water-motor, and the hourly expense was 3fr. 40c. The author considers its use in public lectures for projection of photographs, microscopic preparations, spectra, &c., preferable to to that of the battery, both for convenience and cheapness.

Monthly Mean of Magnetic Observations at the Central Physical Observatory in St. Petersburg in 1872 and 1873.

PROGRAMM DER SOPHIEN-REAL-SCHULE ZU BERLIN. EASTER, 1876.

Passage of Electricity through Gases. By M. OBERBECK.

THE author inserted in the circuit of an induction current a variable spark-interval, a strong resistance in form of a tube with blue vitriol solution, which could be shortened or lengthened, and a galvanometer; and observed each time how much the liquid resistance had to be changed, in order after determinate change of the spark-interval to obtain the same deflection of the galvanometer. The spark-path was enclosed in a glass sphere in which the gas and the pressure could be varied. The conclusions arrived at are briefly these:—1. Gases conduct electricity, in the glowing state, like metallic conductors. The induction spark is a suitable means for the comparative experiments. 2. The conductivities of gases at ordinary pressure are not inconsiderably different from each other. Perhaps this difference may be attributed

to differences of temperature of the spark-interval in the separate gases. 3. With decreasing pressure, the conductivity of gases increases very considerably. At small pressure, the gases differ very little from each other. 4. With less strength of the current there is a decrease of the conductivity, probably due to the less temperature of the gas. 5. The conductivities of gases for electricity and heat stand in no close relation to each other. 6. The values found for the specific resistances investigated are to be distinguished from the resistances at the beginning of the discharge, which have before been investigated by other physicists.

ON ELECTRICAL TRANSMISSIONS THROUGH THE GROUND.

THE idea of electrical transmissions without conducting wires is not new, any more than working electrical apparatus by means of the currents from metallic plates inserted in the ground, improperly called *telluric currents*. From the time when the first telegraph lines were constructed in England and America, various attempts were made in both directions, and results were had, which were at first surprising, but were soon explained.

In a series of notes communicated to the Paris Academy, M. du Moncel casts some fresh light on the subject, from personal researches; and we propose here briefly to notice some of his results.

In experiments in 1842 and 1844, by Messrs. Morse, Gale, Vail, and Rogers—the most important being made on the river Susquehanna, at Havre-de-Grâce, near Baltimore, 1609 metres broad there—these observers concluded that the maximum of electric effect transmitted from one bank of a river to the other was obtained, when the lateral distance of plates sunk at each station was triple the width of the river itself. M. du Moncel observes that this deduction, which might perhaps be generalised if a river were isolated from the ground, cannot be so by reason of participation of this in the conductivity of the ground; and since, when certain very narrow limits are passed, this conductivity is blended with that of the ground itself, so that the resistance then reaches a constant value, the influence of lateral separation of the plates becomes insignificant, whenever this separation represents a resistance equivalent to that of the ground. But this resistance of the ground is itself very variable, and depends on a host of different circumstances—the state of humidity of the ground about the plates, the dimensions of these, the direction of the current sent, and telluric currents which may occur on contact of plates with earthy layers. Taking the water-pipes in the quarter of Grenelle, and a plate of sheet iron 60 square decimetres, buried at one metre depth, and 1735 metres from the point where communication was made with the water-pipes, M. du Moncel found that this resistance of the ground might be represented by 2564 metres of telegraph wire when the plate was positive, and by 3469 when it was negative. But taking a plate of sheet iron one square metre of surface, sunk in a well at the Barrière d'Italie, and a small plate of one square decimetre buried in comparatively dry ground 15 metres from the first, this resistance, notwithstanding suitable watering of the ground about the small plate, reached 17,700 metres when this small plate was negative, and 15,600 when it was positive. With two plates of sheet iron, 60 square decimetres, buried 890 metres apart, this resistance was represented on an average by 7284 metres for one direction of the current, and 7337 metres for the other. Lastly, between water-pipes and gas-pipes the resistance of the ground was, on an average, 420 metres. These differences of resistance of the ground pass unperceived in ordinary telegraphic transmissions, because they are effaced in presence of the total resistance of the circuit, but in transmissions based on derivations of the current as well as on short circuits, it is otherwise, and they must be taken into serious consideration. It may be concluded, from the figures given, that it is not advantageous to interpose the ground in circuits unless when the resistance of the circuit exceeds 10 to 15 kilometres. [M. du Moncel enters into some details as to the causes which influence this resistance of the ground.]

Continuing his investigation, the author seeks to explain—1. The origin of telluric currents developed by plates in communication with a telegraphic circuit connected with the ground. 2. The comparatively large *rôle* played by these currents in electric transmissions. 3. The comparative force of these currents, and the small influence exerted on their intensity, at the end of the line, by derivations which may be produced in its course.

He attributes those of the telluric currents, which spring from unequal moisture of the ground about the buried plates, to unequal energy of oxidation, and sometimes also to more or less oxidised state of their surface of contact. Connecting with a sensitive galvanometer the silex he had used in his former experiments, and using as electrodes oxidised zinc, and zinc newly cleaned, a current was had which gave a deflection of 38°, and whose electro-motive force may be estimated at 0·015, that of a Daniell being unity. Naturally, it is the oxidised plate which is here the positive pole, just as, with the buried plates, it is the plate less attacked, and consequently the one buried in the drier ground, that furnishes this polarity.

The origin of the telluric currents arising from unequal surface of the communicating plates is more complicated, though it is ultimately traceable to a like cause. M. du Moncel shows, in fact, that they result from oxidation being effected more energetically on a small oxidable surface than on a large one; the small plate thus plays the part of electro-positive plate to the large one, and furnishes consequently the negative pole.

If these experiments be repeated with much care, well-cleaned plates being taken, and distilled water as conducting medium, there occur in the earlier part of the experiment two antagonistic actions resulting in alternate inversions of the current, which are interesting to study, and are easily explained. In the first moment, the cause just referred to acting alone, a current proceeds from the large plate to the small; but as the oxidation proceeds, the layer of oxygen becomes

greater on the small plate than on the large, and this small plate tends to become electro-negative to the other; whence results a weakening of the current, followed by inversion, when the effect of oxidation is sufficiently developed. Under the influence of the contrary current the hydrogen then liberated on the small plate tends to reduce the layer of oxygen formed on it, and presently both plates are in the same state of oxidation. Then the greater oxidability of the small plate takes the predominance, and the current is anew reversed, to pass through the same phases again. M. du Moncel has observed as many as nine inversions of this nature in twenty-four hours; but these inversions become wider and wider apart, and a time comes when, the action of the hydrogen becoming insufficient, leaves predominance to the action of the surfaces. Thenceforth the current is always maintained from the large plate to the small.

These currents are also produced with plates of platinum, but *they do not last;* which shows that the action resulting from physical contact of the metal with the liquid must count for something in these different effects, and even determine the original effects. With plates of unequal surface, the currents are always in the same direction, whether the metals are attackable or not; but with plates inserted in a medium unequally moist, it is otherwise, and the currents developed by plates of platinum are generally in opposite direction to those obtained with the oxidable plates. This is because the contact is more perfect in the case of plates immersed in a very moist medium, or in a case of large plates.

M. du Moncel accounts for the comparatively large *rôle* exercised by telluric currents on electric transmissions, by saying that the resistance of the circuit outside of the electric generator affects them much less than those produced by the battery, since with these latter the ground constitutes an electrolyte in which the effects of polarisation are produced on the two electrodes, and with telluric currents these effects are only developed at one electrode, the other determining the electro-motive force. To show the difference of action of the currents according to the portion of moist medium in relation to the generator, M. du Moncel sends the current produced by his silex in contact with zinc and platinum electrodes (not so much as the 15th of a Daniell) through a resistance of 2,032 kilometres, which, added to that of the galvanometer and the stone, formed a total resistance of 4,519 kilometres. He got a constant deflection of 82°. But on sending the current through the circuit after interposing in it the stone fitted with electrodes of platinum, he only got a deflection of 16°, and yet the total resistance of the circuit was only one kilometre above that in the first experiment. It is true that if, in place of the metallic resistance of 2,032 kilometres, he introduced a second silex of 1,754 kilometres resistance, the *rôles* of the two generators were changed, and the advantage then remained entirely with the battery, especially at first. For the rest, the effects of polarisation which cause these reactions depend entirely in the number of elements of the battery and the degree of humidity of the electrolysed medium. Thus, while the current of a single Daniell element produced, in traversing the silex, a deflection which fell from 30° to 16°·65 in five minutes, a battery of twelve Leclanché elements, traversing this same stone, gave, with a derivation of 4 kilometres interposed between the two ends of the galvanometer wire, a deflection of 77° at first, becoming 79° five minutes after.

These effects easily explain how telluric currents, caused by two metallic plates of different nature, buried in the ground, have a comparatively great electro-motive force on resistant circuits, though they proceed, in fact, from only one couple, with relatively small electro-motive force. They explain also the small action of derivations on circuits submitted to these sort of generators. One can understand that if the derivations, in these conditions, weaken, as in ordinary cases, the current at the extremity of the line, they render the current more energetic between the point where they touch the ground, and the electro-positive plate (that furnishing the negative pole), and so produce more energetic oxidation of that plate; whence results an increase of the electro-motive force of the couple, and so a reinforcement of the electric intensity at the extremity of the circuit; which does not occur with an ordinary pile. If we add to this effect a diminution of the effects of polarisation on the electro-negative plate by reason of the reaction produced by the derivations, which play the part of intermediate electrodes, and the lessening of the hurtful effects of the derivations themselves, owing to the weak resistance of the part of the circuit outside of them, we may understand why, in these conditions of the electric generator, the derivations cannot be prejudicial to the intensity of the currents sent, as M. Lenoir's experiments have demonstrated.

PATENTS.

3416. J. H. JOHNSON.—"Improvements in electro-magnetic engines."—1st October, 1875. (A communication.)

3431. J. A. MORTON.—"A new or improved self-adjusting electric-bell indicator."—2nd October.

3440. H. JEWITT.—"Improvements in argand gas burners."—4th October. (A communication.)

3461. W. PROSSER.—"Improvements in lamps adapted to the electric light, and in the manipulation of the means employed for the supply of the electric fluid thereto."—6th October.

3468. T. H. JOHNS.—"Improvements in apparatus for coating metallic sheets with other metals or alloys."—6th October.

3486. A. M. CLARK.—"Improvements in coating or covering metals for preventing their oxidation or corrosion."—7th October. (A communication.)

3509. R. H. COURTENAY.—"An improved thermo-electro-magnetic motor."—9th October.

3600. W. LADD.—"An automatic combined key-switch, for use in connection with submarine or other telegraphic wires."—16th October. (A communication.)